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Universal energy access and rural electrification in developing countries: Promoting investment in clean energy technologies

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Universal Energy Access & Rural Electrification in Developing Countries

Promoting Investment in Clean Energy Technologies

The case of Solar PV in South Saharan Africa

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Outline of Presentation

- Rural electrification – the context
- Solar PV in the development discourse
- Changing conditions for solar PV
- Hybrid PV-diesel for small isolated grids
- Experience with delivery models for SHS
- Issues of consideration

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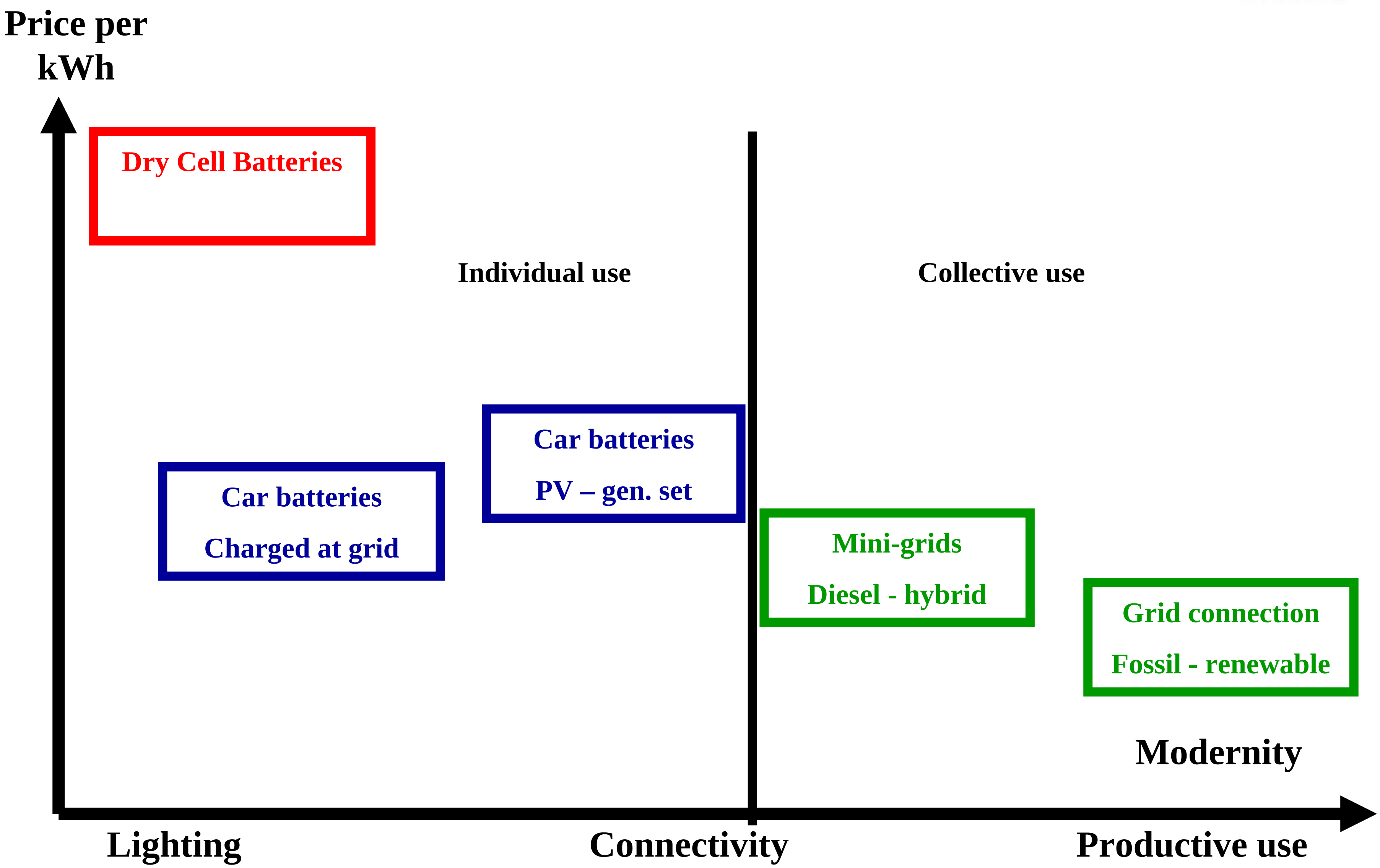
Rural electrification – the context

- Electricity is one among other preconditions for development
- Improvements still slow:
  - Rural electrification was not the main objective of liberalization
  - It takes time for electricity agencies and electricity funds to gain momentum

Historically low electrification rates in Africa


Price per kWh
Dry Cell Batteries
Individual use
Collective use
Car batteries
PV – gen. set
Car batteries
Charged at grid
Mini-grids
Diesel - hybrid
Grid connection
Fossil - renewable
Modernity
Lighting
Connectivity
Productive use

Solar PV (SHS) historically

- High expectations in the 1970's
  - high and increasing oil prices
  - rapid development of technology
  - aspirations of economic development in rural areas
- Seemingly good arguments
  - leap-frog technology, high solar irradiation, long lifetime, low maintenance, difficult access to fossil fuel
- Finding problems to fit the solutions
  - Converging interests between donors and industry
    - green movement, decentralisation, SHS as a liberal approach, climate change concerns
    - PRS contract (10 % of annual EU production)

SHS - status in the new millennium

Bad reputation

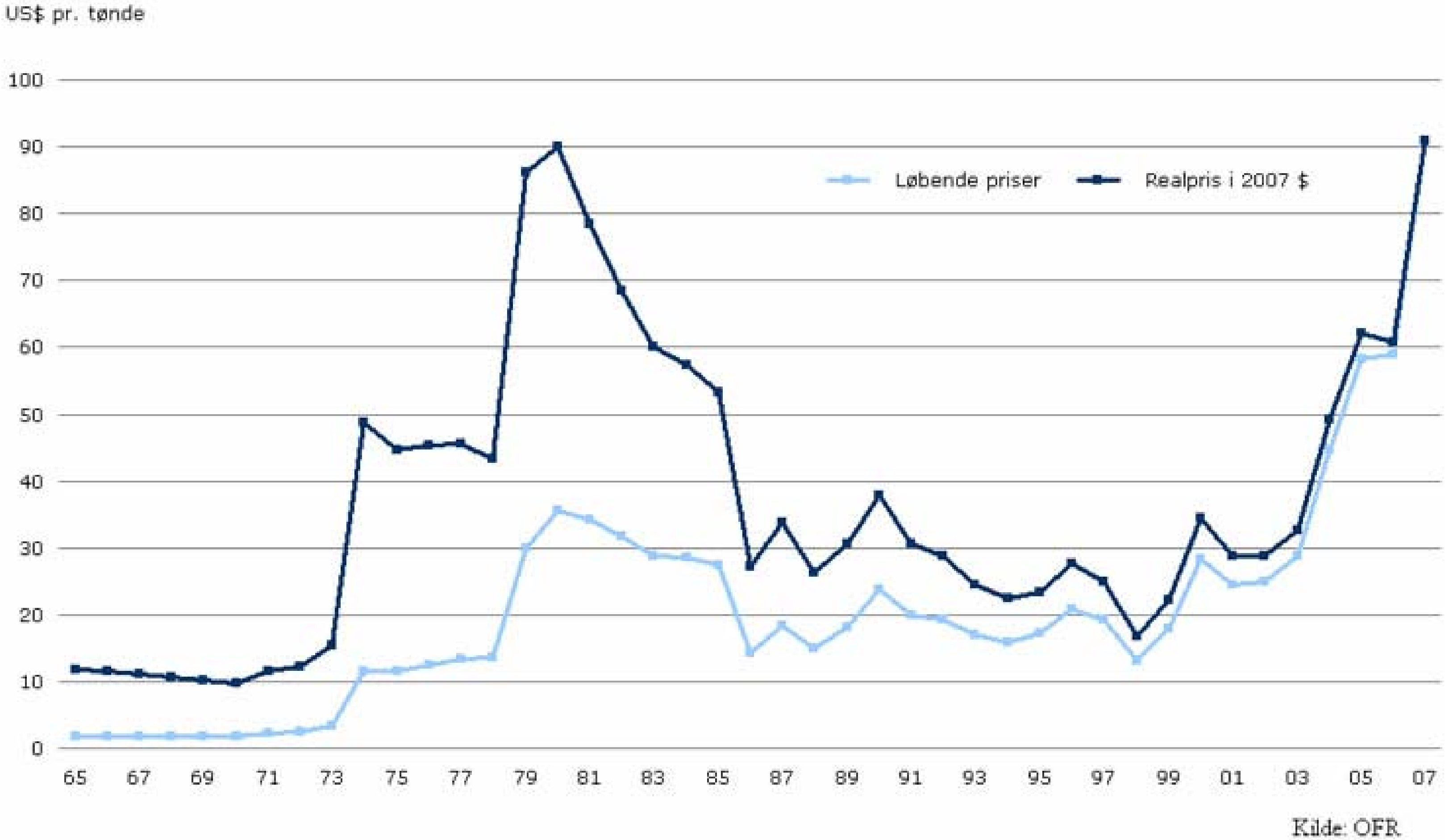
- Donor driven agenda
- Second best solution
  - SHS mainly for communicative and not for productive use
  - Not an alternative to grid connection
- Donated systems to schools, health centres, community centres have a high failure rate
- Theft a great problem

Matured technology

- Increasing markets
  - 2.5 million SHS worldwide
  - 0.5 million SHS in Africa
- Especially in a few countries

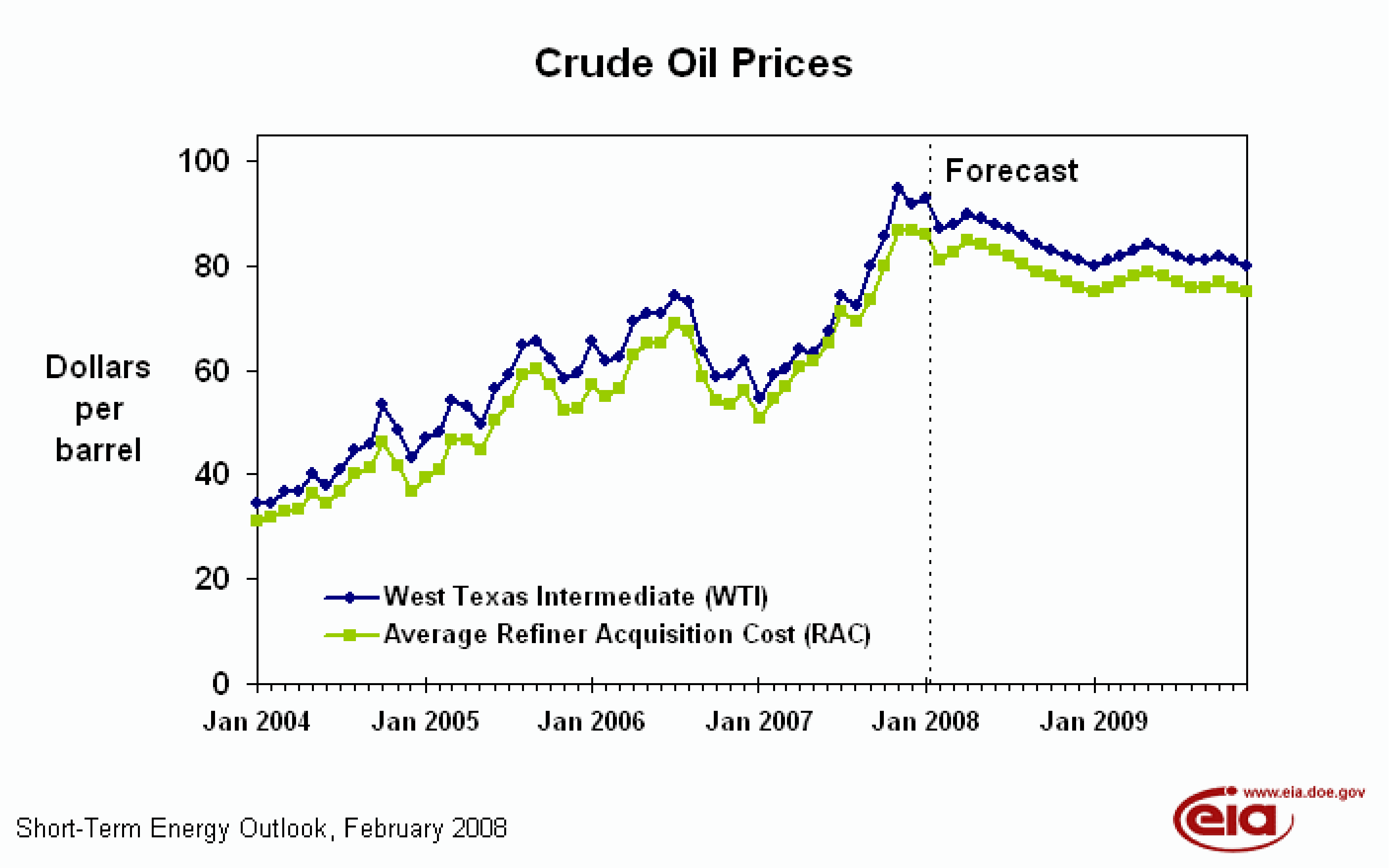
Kenya	200,000
South Africa	150,000
Morocco	37,000
Zimbabwe	15,000

Increasing oil prices
Actual prices above 1979 level



-and are expected to remain high

Oil prices forecast, DOE



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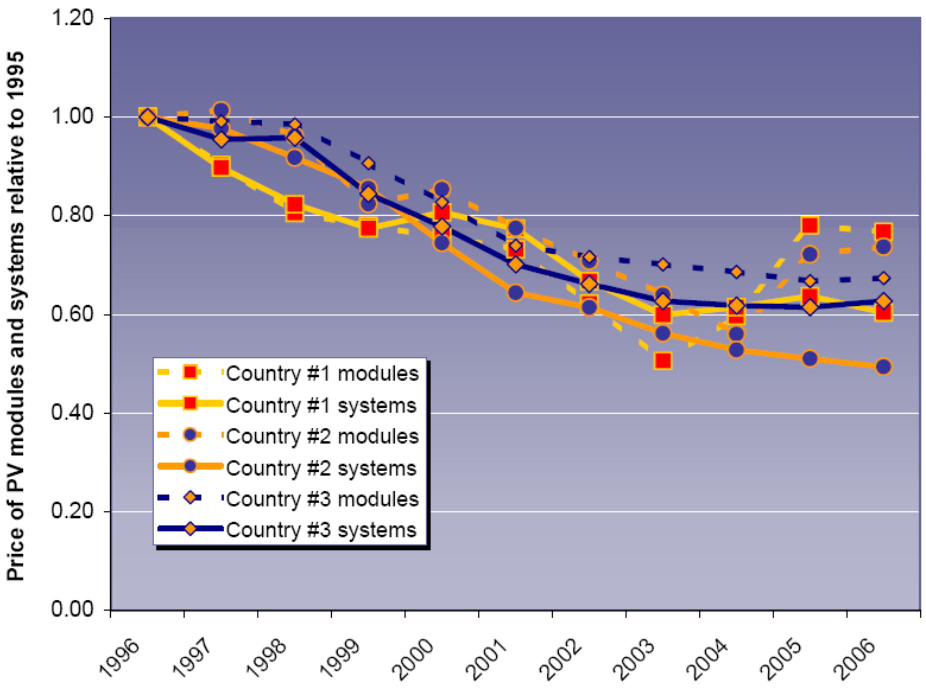
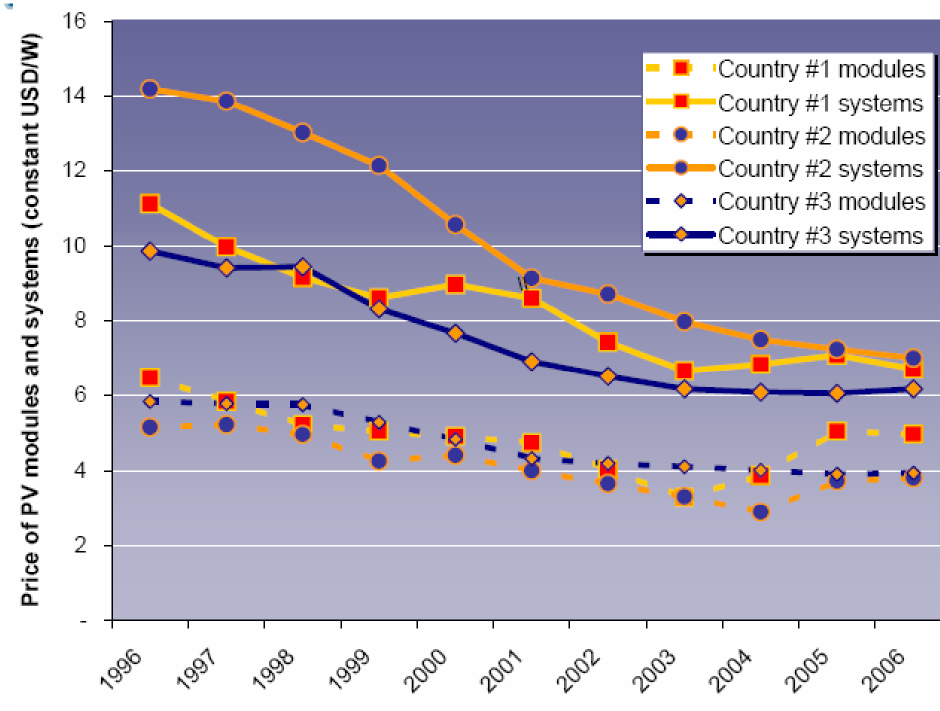
Price of PV modules and systems accounting for inflation effects





Source: IEA Photovoltaic Power Systems Programme

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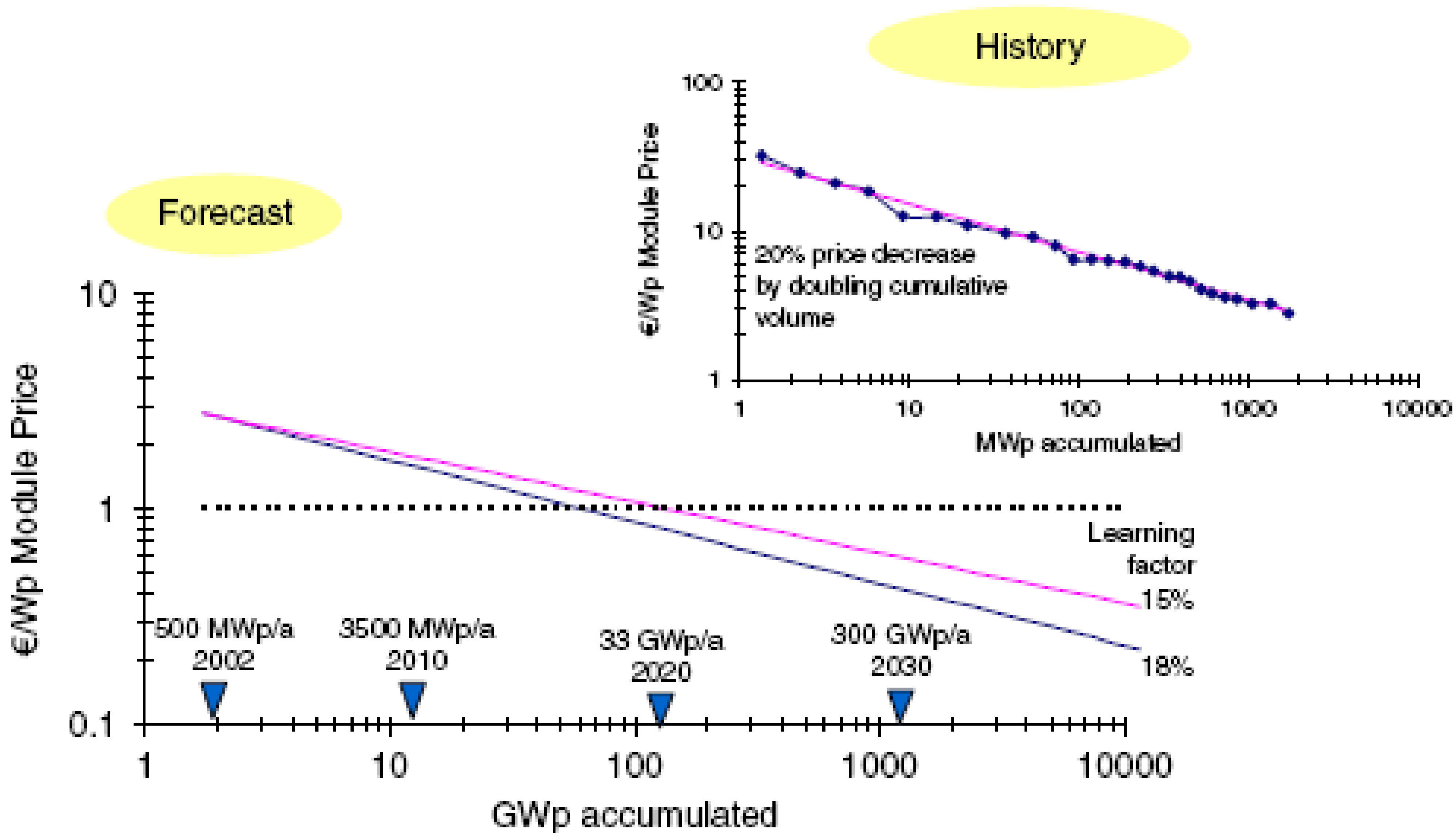

Fig. 19. Price experience curves for PV modules.

Source: Hoffmann, 2006

Solar PV in hybrid systems

- PV hybrid is future safe compared to SHS
  - established high voltage grid for productive use and for future grid connection
  - useful for building up load
- PV hybrid (wind) is mainly used for specific purpose
  - isolated nature camps (Thailand)
  - small islands communities
  - test plants (ex. 500 kW in Thailand)
  - test system at Risø National Laboratories
- Increasing no. of reports on economic feasibility of hybrid systems compared to diesel
- Creation of a new task force for Hybrid systems in the International Energy Agency (IEA)

Solar PV in hybrid systems

	PV (kW) kW	Gen. set KW	Battery 3 kWh	Converter KW	Renewables %	Diesel liters	Gen. set hours	Production kWh
Hybrid	12	15	20	6	0,40	9.343	2.054	40150
Diesel		15			-	22.783	8.760	40150

6 % interest (real)

	Crude oil USD/barril	Diesel EUR/liter	Initial capital EUR	Operating cost EUR/yr	Total NPC EUR	Electricity EUR/kWh	Price margin EUR/kWh
Hybrid	30	0,33		7.157	155.605	0,30	
Hybrid	60	0,48	64.113	8.527	173.121	0,34	0,10
Hybrid	90	0,63		9.960	191.435	0,37	
Gen. set	30	0,33		15.445	203.853	0,40	
Gen. set	60	0,48	6.407	18.787	246.569	0,48	0,20
Gen. set	90	0,63		22.281	291.227	0,57	

15 % interest (real)

Hybrid	90	0,63	37.313	12.994	121.309	0,70
Genset	90	0,63	6.407	22.260	150.297	0,87

Calculation by means of HOMER from NREL

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PV – hybrid feasibility depends on context

- Calculations are sensitive to:
  - system size, system configuration
  - existing and future load patterns
  - battery lifetime
- A level playing field for PV and diesel is a precondition
  - fuel taxation, fuel subsidies
  - taxation on material (also replacements)
- Continued project support or specific subsidies for market built up is recommendable
  - transactions costs
  - costs of market creation

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Delivery models for SHS

- Donation model
  - market introduction, institutions,
  - most countries
- Cash sales model
  - Kenya,
- Programme model
  - Zimbabwe
- Fee-for-service model
  - South Africa

How do the models reduce prices?

- Competition, the main challenge
  - Private sales model, may favour small local enterprises,
    - low prices in Kenya
  - Programme model may create market distortion
  - Concession model, favours international companies,
    - big orders may reduce prices
- Financing up front costs
  - modular sale in Kenya
  - programme model have been successful in involving existing banks in credit for SHS (low rate, long term)
  - easier for big companies to achieve credit at reasonable terms

How do the models reduce prices ?

- Subsidies
  - Rural electrification is generally subsidized, so create a level playing field
  - Subsidies justified to create an initial market
    - Kenya market model without subsidies
    - Programme financing schemes do have an indirect subsidy element
    - SA fee for service model with 80 % investment subsidies

The question of maintenance

- Private ownership gives incentives for good maintenance.
  - Difficult for rural people to discern good and bad quality PV
  - Lack of skilled personnel
- Programme models generally establish support schemes, train technicians, and ensures quality.
  - Technicians might leave, quality assurance might not be enough
- Fee for service model leaves all maintenance to the service provider
  - Low commitment from user,
  - Utility may go bankrupt

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Issues for consideration

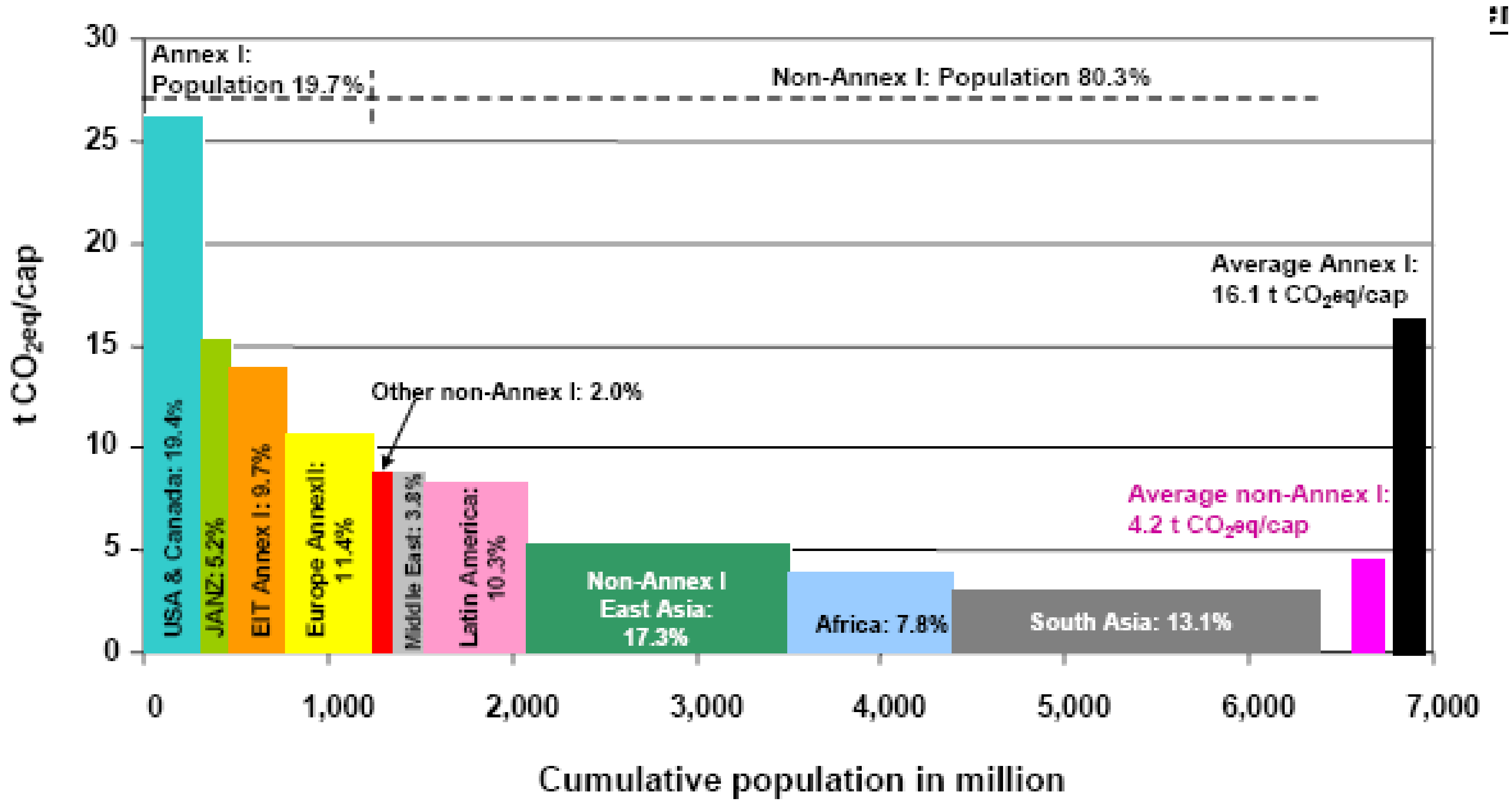
- Most economic activity lays outside the reach of external parties
- Success and failure of delivery models, strongly depending on context, and market development level
  - Private led delivery is ideal at the early and late stage of market development
  - Programme approaches providing lending and quality insurance may be an option at intermediate market development level
  - Fee for service models an option for large scale and committed efforts from governments

Issues for consideration

- Long term political commitment to market stimulation
  - unfortunately not a strong virtue of donor programmes
- Inclusion of ‘established’ financial sector
  - process is more important than numbers
- Subsidy
  - levelling the playing field compared to other technologies
  - targeted subsidies are important to stimulate the market
  - clear, understandable and communicated exit strategy

Regional per capita GHG emissions

(all Kyoto gases, including those from land-use)



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Thanks for your attention !